WATER QUALITY BENEFITS: AN EXPERIMENTL ANALYSIS OF THE LAKES AT OKOBOJI, IOWA

by

Ralph C. d'Arge
Department of Economics
University of Wyoming
Laramie, WY 82071

With the assistance of
Jason Shogren
University of Stockholm
Stockholm, Sweden

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Project Officer

Dr. Alan Carlin
Office of Planning and Management
U.S. Environmental Protection Agency
Washington, DC 20460

Resource and Environmental Economics Laboratory
Department of Economics
University of Wyoming
P.O. Box 3985 University Station
Laramie, WY 82071

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ABSTRACT

Benefits from the improvement of water quality has been the object of substantial economic research during the past twenty years. Four distinct valuation methods have evolved, each with advantages and some inherent weaknesses. This study develops a set of experiments and hypotheses on the magnitude of various measures of benefits. It also contains an experiment on the degree of bias on one of the standard tools used in assessing water quality benefits, the water quality ladder.

The experiments are applied in a field context developed for the Lake Okoboji area of Iowa. These glacial lakes offer a relatively unique set of characteristics for experimentation since they are connected and have about the same amenities except water quality. Five measures of water quality value are developed and tested including: Realtor's best estimate; comparison of imputed lake frontage prices; a pooled regression estimate based on assessed valuation; marginal willingness to pay; and willingness to be compensated, each utilizing the contingent valuation method on a very limited sample. As might be expected, the values derived from the different approaches were similiar in magnitude, except for the compensation measure. Problems with obtaining valid estimates of compensation were encountered. However, the other values might be expected to be similiar since an active "implicit" market for water quality through residence site selection has been operating for over 30 years. Results obtained suggest that from 13 to 23 percent of the residence value (per square foot) is accounted for by water quality increasing from boating/fishing to swimming/drinking. This would yield a sizable benefit if it could be translated to National levels. Five hypotheses are also tested to find out whether the empirical observations conformed to theoretical expectation. In most cases, the hypotheses were confirmed, with substantial qualification. The water quality ladder used in contingent valuation studies was examined as to bias because of complementarity or substitution between water based recreation activities. Some empirical evidence of bias was discovered.

INTRODUCTION

The benefits of improved water quality have been measured in a myriad set of ways using techniques to infer valuation (see refs. 6, 8, 10). The most common technique has been to estimate the change in visitor days by type of recreational activity and place a value on each type of visitor day (ref. 8). For the most part, these economic values are not site specific but are obtained from generalized studies of the value of recreational experiences. The second technique is to compare two or more water based recreational sites that are similar except for water quality and infer the adjusted difference in land/house or other fixed site values is due to the difference in water quality. This approach has the inherent difficulty of attempting to control for unknown or omitted differences between the sites. A third technique is to ask individuals to reveal their preferences for improved water quality either at a specific site or in more general terms for locations they may use or be aware of (ref. 3). This technique has the difficulty of obtaining truthful and unambiguous preferences as well as identifying the relevant groups who generate value. A fourth technique utilizes market information of some type to infer water quality benefits (ref. 10). For example, expenditure on equipment, travel, or wages foregone, are used to infer values of different sites.

For simplicity, we shall identify these four broad techniques as the: 1.) Visitor Day Method, 2.) Site Valuation Method, 3.) Contingent Valuation Method, and 4.) Market Valuation Method.

Most recent research studies on water quality have concentrated on the interpretation and application of 3.) and 4.) above. In this study, we have selected a pair of Lakes which will allow direct comparisons of techniques 2.), 3.) and 4.). We have also developed a partial experiment applied to these lakes to test whether the water quality “ladder” approach used extensively under category 3.) above is a valid approach without serious inherent economic biases.

The site selected for detailed analysis are the two glacial lakes called West Okoboji and East Okoboji in northwest Iowa. The lakes are connected by a canal and are very similar from a visual and locational perspective. However, they differ markedly in one group of characteristics, namely recreational based water quality. East Okoboji is more shallow and has a relatively greater waste input from agricultural and natural runoff. In consequence, during part of the summer recreational months, (typically more than thirty days) East Okoboji supports dense blooms of algae resulting in a lime green color and noticeable odor from decaying algae. Alternatively, West Okoboji rarely (less than five days) has a noticeable algae bloom and turbidity is typically characterized as clean in the summer months.

Both lakes are typical water based recreation sites with more than 75 percent of the summer resident population accounted for by second homeowner’s and seasonal renters. Each lake contains a predominance of individual homes and dock facilities around it with only limited public access. Neither one has a visual or locational advantage over the other in that they are almost equal in distance from the population centers of Iowa and Minnesota. Each offers about the same mix of water based recreational activities and there is almost unlimited and costless substitution between them because of a connecting canal. For example, except for a small amount of travel time, fishermen, swimmers, water skiers, sailing enthusiasts, speed boaters etc. can use either lake. The difference in valuation of the two lakes then should reflect only differences in preferences for water quality. That is, differences in rents or housing values should fully reflect willingness to pay for improved water quality, i.e., clear versus green water, and not differences in substitution among activities or their costs between the lakes. Water based activity levels are thereby influenced only slightly by water pollution in that there is substitution across adjacent sites, and other factors such as congestion do not currently play an offsetting role.

In this paper, three alternative techniques of measuring the benefits of water quality improvement are explored and applied to the Lake Okoboji region on an experimental basis. These are: 1.) a site valuation based on comparing property values between the two adjacent lakes, 2.) a market valuation by asking a sample of realtors in the area the causes for the observed price differential between the lakes and 3.) a contingent valuation approach using a limited sample of site dwellers to estimate their willingness to pay for improved water quality. In so doing, we have attempted to control for most, if not all, other influences which would bias estimates of water quality benefits.

LAKE OKOBOJI REGION

"There is something majestically splendid, something regal, about the deep blue waters of West Okoboji Lake, to enchant as they sparkle in the sunshine" is the way one writer had described the lakes in the distant past (Elston, ref. 1). The lakes have been described as the cradle of the Dakota Sioux nation and are perhaps historically best remembered for the Spirit Lake Massacre of early settlers in 1857. However, following some developments around them in the early twentieth century, they were characterized as follows: "the stench of rotting algae (sic) was almost unbearable at times on the Okoboji side and contributed considerable toward loss of trade there" (Elston, op. cit.). In the late 1930's. a Works Progress Administration project was' undertaken to provide sewage disposal and treatment for the commercial and residential housing located on the eastside of West Okoboji. The main sewage line ran from the town of Okoboji to south of Arnold's Park (see map in Figure 1), and removed most of the organic wastes entering East and West Okoboji in this area. While, West Okoboji has remained relatively clear, East Okoboji almost every summer undergoes a substantial algal bloom. A short canal under Highway 71 between the towns of Okoboji and Arnold's Park connects the two lakes allowing limited mixing between lakes and the movement of some types and sizes of boats between them. In consequence, individuals with motor boats can easily fish, swim, water-ski, or use the beaches on either lake. The time and cost factor would typically be less than five percent of the total cost of participating in the activity. However, some activities such as pleasure sailing, participation in sailing races, aesthetic enjoyment of beach fronts, and dock-based recreation, are not easily

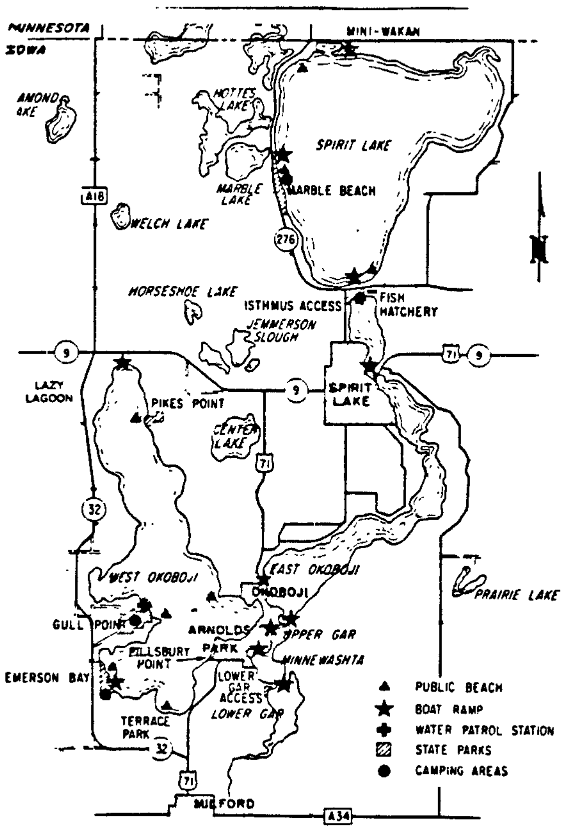

Figure 1. Map of the Lake Okoboji Area

TABLE 1. SUMMARY OF PERCEPTION OF TYPICAL WATER QUALITY, SAMPLE SURVEY, EAST AND WEST OKOBOJI LAKES, 100 DAYS IN SUMMER AND EARLY FALL

	Mean of Number of Summer Days Perceived*	
Level of Water Quality***	East Okoboji Lake	West Okoboji Lake
E	0.50	0
D	2.10	0.25
C	20.50	5.25
B	75.40	50.0
A	1.50	44.50
	100.0	100.0

*Sample size was 20.
** Water quality represented by the following scale (or ladder).

***Best Water quality	10	A	Drinkable, swimmable, fishable, boatable
	9		
	8		
	7	B	Swimmable, fishable, boatable
	6		
	5	C	Fishable, boatable
	4		
	3	D	Boatable
	2		
	1	E	No activity recommended
Worst Water quality	0		

substituted for between lakes. Because of a bridge over the canal sailing vessels cannot easily be moved from one lake to the other. And water based recreation and aesthetic activities around the cabin or home of course cannot be substituted for, at all.

Historically, real estate development has proceeded with substantial second home development along the shore of West Okoboji commencing in the early 1900's and preceding to current times. The development of East Okoboji has proceeded at a slower pace, with smaller, lower valued cabins and homes being built along this lake. Assessed valuation and average square feet of residences demonstrates this. The average assessed valuation per residence for West Okoboji in 1983 was $161,716 and average square feet of residence, 2,152. For East Okoboji, the average assessed valuation was only $161,484 and typical residence, 1415 square feet. Thus, there is a substantial difference in total valuation and value per square foot at the two locations. Given that East Okoboji has been a less desirable location because of water quality, land values have been lower, development occurring at a slower rate, and lower priced housing was erected. In Table 1 are recorded the perception of a sample of residents for water quality at the two lakes. It is clear that residents(home owners) perceive water quality as being less desirable for the east lake. Almost 95 percent perceive the west lake as being suitable for all water based recreation with the possible exception of drinking, while the east lake is perceived as not fit for drinking and perhaps not for swimming.

One substantial conceptual problem with inter-lake comparisons is that individuals with preferences for higher water quality have located at West Okoboji while those with lesser preferences for water quality or a greater preferences for a particular mix of recreation activities have located on the east lake. In consequence, the observed difference in values between the lakes may partially be determined by differences in preferences. This is also suggested by the ranked reasons for housing purchased where price and location were more important for East Okoboji residents and of less importance by West Okoboji residents (see Appendix 3, Table 11).

In order to examine preferences, a simple utility maximization model is proposed where

$$\mu(C, W) \tag{1}$$

is the individual utility function with C being a composite commodity presumed unrelated to water based recreation and W a measure of water quality. In terms of this function, $\mu_C, \mu_W \geq 0$; μ_{CC}; $\mu_{WW} \leq 0$; and $\mu_{CW} \lesseqgtr 0$ where subscripts identify derivatives. In addition to the utility function, a budget constraint is proposed where the price of the composite commodity equals 1 and where the individual takes the price paid for water quality as given, and equal to R. Then, with Y denoting disposable personal income:

$$Y - C - R \cdot W \geq 0 \tag{2}$$

Taking the first order conditions for this simple model, one obtains

$$\frac{\partial L}{\partial C} = \mu_C - \lambda \leqq 0 \tag{3}$$

$$\frac{\partial L}{\partial W} = \mu_W - \lambda R \leqq 0 \tag{4}$$

If R is a rental gradient for property which depends on water quality (net of effects from other characteristics of housing), then R•W needs to be rewritten as R(W) and (4) changes to:

$$\mu_W - \lambda R' \leqq 0 \tag{5}$$

and

$$\frac{\mu_W}{\mu_C} = R' \tag{6}$$

which is a common result observed in studies on environmental quality and housing values (see for example refs. 6 and 9). Basically, it states that in equilibrium, the rational purchaser of property will equate the marginal rate of substitution between water quality and consumption with the "rental gradient" associated with properties where each is differentiated by levels of water quality. In Figure 2, this simple model is graphically depicted. If the individual purchase of improved water quality (by purchase of a new site) has no impact on the housing market equilibrium with respect to water quality or other characteristics of housing, then the rental gradient is a straight line such as aa in Figure 2. That is, the budget line for the individual house purchaser with certain water quality attributes is linear since changes in purchases by the individual has no impact on the "price" of water quality as reflected in the rental gradient. However, if the purchaser, by his actions in the housing market, influences this "price" then the appropriate budget line (or rental gradient) would be aa′ in Figure 2. Which shape will the budget line or real gradient be? If the individual decides to purchase more water quality by locating or relocating at the cleaner lake, he will shift demand for water quality upward, thus raising its price. Thus, if markets for housing have typical characteristics in terms of a supply and demand, the budget line (rental gradient) shall be either linear such as aa or concave downward such as aa′.

In Figure 2, ΔC measures the income loss (in commodity terms) that would leave the individual at the same utility level as before the change in water quality (ΔWQ). The ΔR measures the change in rent along the rent gradient induced by a change in water quality ΔWQ. As was demon,strated elsewhere by Schulze, d'Arge, and Brookshire among others, AR > AC if the typical properties of indifference curves hold and the rent gradient is not somehow extremely distorted (ref. 11). Note further that, in Figure 2, $\Delta R > \Delta R$. Thus, if the purchaser does influence the rent gradient through inducing a higher "price" for water quality, the resulting observed hedonic rent estimate will overstate willingness to pay by even more than if the gradient were linear. The bias for rent gradients (hedonic prices) to overestimate marginal

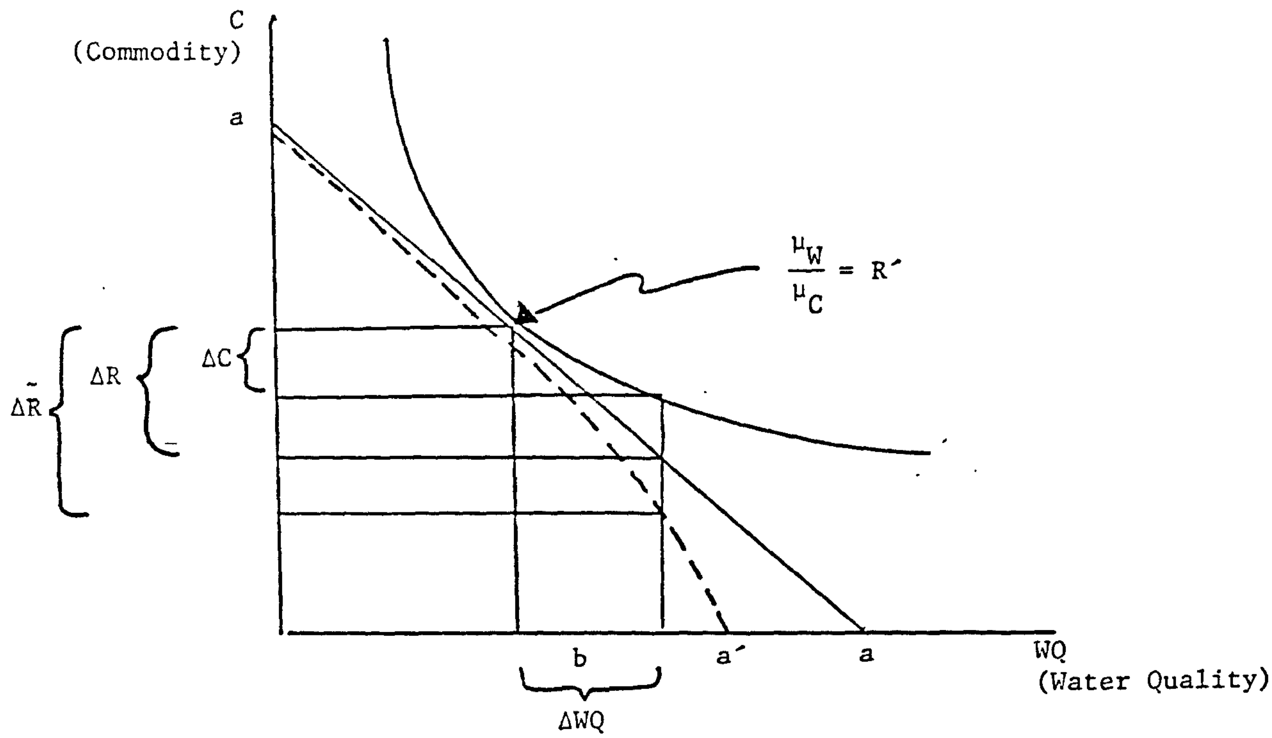

Figure 2. Rent Gradient and Compensating Surplus

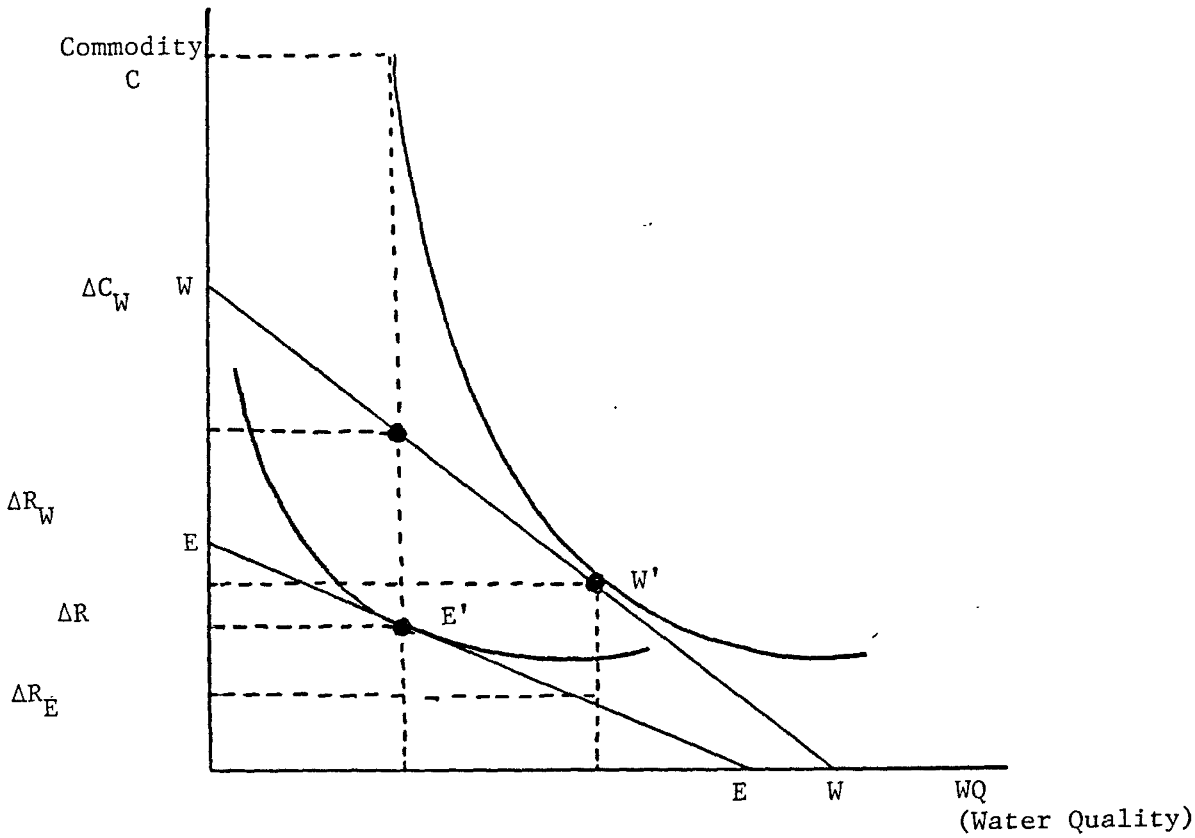

Figure 3. Differences in Rent Gradients

willingness to pay is thereby even greater when individual purchasers may influence the demand for an environmental attribute. In a relatively small residential market such as the Lake Okoboji area, single sales may in fact influence housing prices, especially for relatively high priced vacation homes. (There are less than 100 on both lakes). Thus, we would anticipate that observed prices paid or inferred from assessor's valuations for higher water quality derived from a hedonic price equation would exceed estimates of marginal willingness to pay. Alternatively, amounts of compensation necessary to maintain individual utility with reduced water quality would substantially <u>exceed</u> estimates derived from the rental gradient or property value differentials. In Figure 3, this difference is demonstrated by comparing with Also in Figure 3, two distinct rent gradients are depicted for the Lake Okoboji situation where EE is for East Okoboji Lake and WW for West Okoboji Lake. The typical resident at East Okoboji has a lower income, perhaps less of a preference for water quality, and may confront a less steep budget line (or rent gradient) for water quality with a equilibrium at E'. The resident of West Okoboji typically has a higher income, greater environmental preferences, and steeper budget line (a rent gradient). What does the difference in rent (property value) tell us about preferences as measured by AR in Figure 3? Very little, since this is a difference between two equilibrium of individuals with different preferences, budgets, and imputed "prices" for water quality. Only in extremely special cases would AR coincide with ΔR_W, or both would equal ΔC_W. However, all is not lost in terms of this comparative exercise. For small changes in water quality, we would anticipate that the rental gradient would approximate compensation or marginal willingness to pay for each lake. And through competition, at the margin, we would anticipate that the "price" differential between lakes would approximate differences in utility levels of the residents. If this were not the case, individuals, by relocation, could increase their utility, up to a point, in a relatively lumpy housing market.

For analytical purposes, we can set forth the following propositions with regard to the valuation methods experimented with in this paper.

1). Compensation for $-\Delta WQ$ $\geq |\Delta R| \geq$ marginal willingness to pay for $+WQ$

2). $\tilde{\Delta R} > \Delta R$ with water quality improvements

3). $\tilde{\Delta R} < \Delta R$ with water quality losses

4). Marginal willingness to pay by residents East Okoboji Lake < Marginal willingness to pay by residents at West Okoboji Lake

5). AR for West Okoboji Lake > AR for East Okoboji Lake

These five propositions are partially tested and reported on in the following sections of the paper.

Before proceeding one can make some general inferences “a priori” about the magnitudes derived from the methods outlined in the introduction. The visitor day method (VDM), because of the fixed price per user day will tend to overstate benefits of water quality improvements because it does not consider diminishing marginal rates of substitution between water quality and other commodities or the possibility of site and activity substitution. The site valuation method can be biased upward or downward depending on the degree of difference between preferences, income, and rent gradients confronting the different residents. The contingent valuation method will be relatively unbiased if problems of sampling, strategic behavior, information bias, and hypothetical bias can be minimized. Finally, the market valuation method will be unbiased unless there are non-competitive, information, or other natural distortions operating on this market.

THE WATER QUALITY LADDER

Introduction

As part of this study, benefits from improved water quality are being estimated applying the contingent valuation method. Individuals are asked to reveal their willingness to pay or accept compensation for differing levels of water quality using a subjective index of water quality such as boating, fishing, swimming, and drinking. The subjective indices are applied via a Water Quality Ladder. A Water Quality Ladder transforms scientific measures of water quality conditions into subjective indices understandable to average citizens.

Accurate value responses from subjective indices implies that these indices contain distinct and separable activities. This separability allows say, for exact measures of value for an improvement in water quality from “beatable” to “fishable.” However, if the subjective indices are not separable or distinct, i.e., they are complements or substitutes, the responses may not accurately measure benefits of water quality improvements. Complementarity or substitutability can bias the willingness to pay responses. This paper will introduce a modified Water Quality Ladder that attempts to incorporate the possibility of complementarity or substitutability into the willingness to pay response, thereby making responses more accurately reflect benefits of water quality improvements.

The next section will examine the standard Water Quality Ladder developed by Mitchell and associates at Resources for the Future (ref. 5). The next section 3.3 will introduce the modified Water Quality Ladder and discuss the possibilities of implementation in this and other studies.

Standard Water Quality Ladder

Research undertaken at Resources for the Future by R.C. Mitchell and R.T. Carson attempted to measure the benefits of water quality improvements using a water quality ladder approach (ref. 5). Willingness to pay estimates were solicited for “beatable”, “fishable,” “swimmable”, and “drinkable” levels of water quality. Descriptions of the levels were placed on a Water Quality Ladder (see Figure 4). Mitchell and Carson used the subjective indices to avoid problems of confusion resulting from explaining the meaning of abstract scientific measures of water quality conditions.

The ladder is a form of self-anchoring survey. The top of the ladder is the “best possible water quality” and the bottom is the “worst possible water quality.” The levels (A,B,C,D,E,) were numerically estimated by indexing five objective scientific measures of water quality (variation of National Sanitation Foundation’s Water Quality Index) . Level E is so polluted that no plant or animal life exists and smells bad; level D represents water quality suitable for boating; level C - water quality can support game fish, thereby allowing fishing activities; level B - water quality is clean enough that people can swim; and level A is where people can drink directly from the lake or stream.

Interviewers asked individuals to value hypothetical increases in water quality using the ladder as a reference. “’Individuals were asked to reveal their willingness to pay (in taxes or higher prices) to move from level E to level D, “boatable.” Once that willingness to pay was established, the individual was queried on his/her willingness to pay to move from “beatable” to level C, “swimmable.” The individual works his/her way up the ladder establishing willingness to pay for increases in water quality and stopping when level A is reached. By using the ladder to produce willingness to pay responses, Mitchell and Carson implicitly assume that boating, fishing, swimming, and drinking are distinct and separable activities. This implies that individuals have separable utility functions of the form:

$$u = U(B,F,F,D) = U[g^1(B), g^2(F), g^3(S), g^4(D)] \qquad (7)$$

Where B - Boating
F - Fishing
S - Swimming
D - Drinking

Separability allows willingness to pay for the subjective indices to directly represent different levels of water quality. Therefore, obtaining accurate willingness to pay responses using the ladder is conditional on the qualification of separable utility functions.

The utility function U(B,F,S,D,Y), where Y is income, is said to be separable if the marginal rate of substitution (MRS) between two goods is independent of other goods. Symbolically, the above statement can be derived as follows:

$$\frac{\partial MRS_{FY}}{\partial B} = 0 \qquad (8)$$

where $MRS_{FY} = \frac{U_F}{U_Y} = "P" = WTP_{FY}$

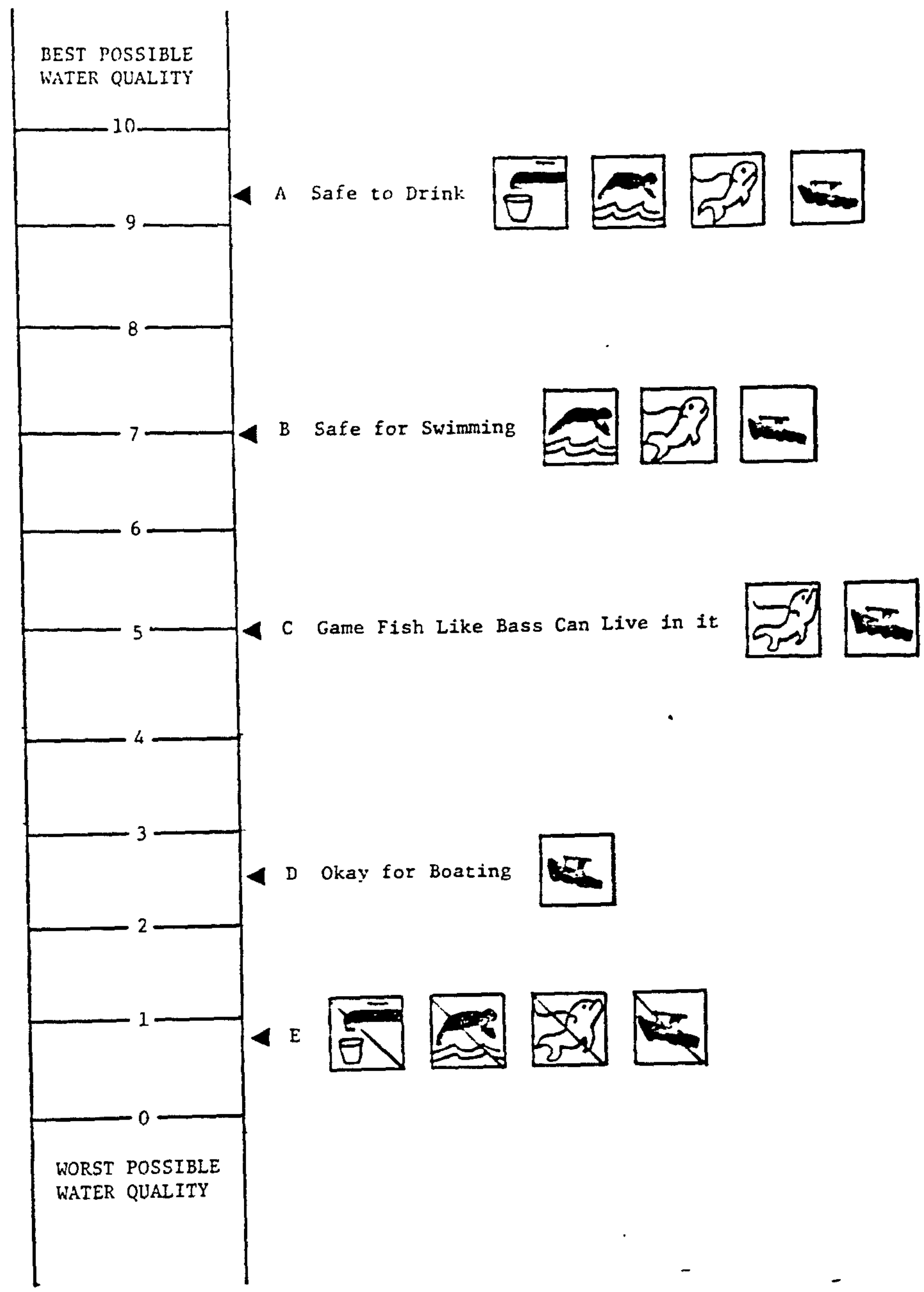

Figure 4. Water Quality Ladder [From Mitchell/Carson (1981)]

with U_F - Marginal utility of fishable water
U_Y - Marginal utility of income
P - "Price" or willingness to pay for fishable water at the margin

As long as the above condition holds the individual can separate fishing from boating in his utility function, the individual's revealed willingness to pay for fishable water will be an accurate response.

Now consider an example of where

$$\frac{\partial MRS_{FY}}{\partial B} \neq 0 \tag{9}$$

This implies that the utility function is no longer separable and that fishing and boating are complements or substitutes. Fishing and boating are complements or substitutes if

$$\frac{\partial MRS_{FY}}{\partial B} \gtrless 0 \tag{10}$$

Examples of fishing and boating as either complements or substitutes are evident. Many fishermen prefer using a boat to fish from, thereby implying complementarity. Other fishermen feel boats only disrupt the fishing area, thereby implying some form of substitutability. The hypothesis that fishing and boating are neutral activities seems unrealistic. Mitchell and Carson found a number of individual's responding with zero willingness to pay for boatable water quality, and positive willingness to pay for fishable water quality. Results similar to this were encountered in our limited survey. The implication is that willingness to pay was for fishing alone. However, if fishing and boating were complements the willingness to pay for fishable water quality may include some amount for boating, i.e., the individual was a boat fisherman.

The non-separability can cause the willingness to pay based benefit measure to over or understate benefits if activities are complements or substitutes, respectively.

$$MRS_{FY}\Big|_{B=\bar{B}} \gtrless MRS_{FY}\Big|_{B=0} \qquad \begin{array}{l}\text{If complements}\\ \text{If substitutes}\end{array} \tag{11}$$

The willingness to pay for fishing given implicit knowledge that boating potential exists $(MRS_{FY}\big|_{B=\bar{B}})$ will be greater than willingness to pay for for fishing given no possibility of boating if they are complements. It would be just the opposite for substitutes. If there is some amount of non-neutrality (i.e., complements or substitutes), then the individual's willingness to pay response may be overestimated (complements) or under estimated (substitutes). thereby possibly biasing the revealed willingness to pay for different levels of water quality.

Modified Water Quality Ladder

In order to correct for the possible willingness to pay bias caused by a nonseparable utility function, a modified Water Quality Ladder is introduced (Figure 4). The modified ladder attempts to measure the existence and extent of complementarity or substitutability between the subjective indices. The ladder is analogous to the Mitchell-Carson ladder in that it ranks water quality from 1 to 10. The modified ladder differs in that it incorporates more hypothetical or actual situations.

The individual is asked to reveal his willingness to pay for improved water quality from level E to the boatable level D. Next, the individual is asked to reveal willingness to pay for increases in water quality to the fishable level given implicit knowledge of boating potential ($WTP_F\big|_{B=\bar{B}}$). The modified ladder differs from the Mitchell/Carson by introducing two additional hypothetical situations at the fishable water quality level. The individual is asked to reveal his willingness to pay for fishable water quality where fishing exists, but boating is prohibited (by legal institutions), $WTP_F\big|_{B=0}$. Then the individual is asked for a willingness to pay for fishable water quality where boating is permitted but fishing is prohibited, $WTP_B\big|_{F=0}$. This last willingness to pay will identify boaters who appreciate fishable water quality but do not want to fish.

The extent of complementarity substitutability, or neutrality can then be partially assessed as follows:

$$WTP_F\big|_{B=\bar{B}} \begin{matrix} > \\ = \\ < \end{matrix} WTP_F\big|_{B=0} + WTP_B\big|_{F=0} \quad \begin{matrix} \text{Complements} \\ \text{Neutral} \\ \text{Substitutes} \end{matrix} \tag{12}$$

Complementarity between fishing and boating implies the $WTP_F\big|_{B=\bar{B}}$ will be greater than the combination of fishing or boating with restrictions, $WTP_F{}_{B=0} + WTP_B{}_{F=0}$ (given fishable water quality). This makes intuitive sense in that boat fishermen should be willing to pay more to participate in boat fishing than just to boat or to fish from the shoreline. Substitution implies that $WTP_F\big|_{B=\bar{B}}$ is less than the willingness to pay for the combination of fishing and boating with restrictions, $WTP_F\big|_{B=0} + WTP_B\big|_{F=0}$. If $WTP_F\big|_{B=\bar{B}} = WTP_F\big|_{B=0} + WTP_B\big|_{F=0}$ then fishing and boating are neutral activities, implying that $\frac{\partial MRS_{FY}}{\partial B} =$ 0, thus suggesting separability in the individuals utility function. In that case the modified ladder would yield willingness to pay estimates equivalent to the Mitchell-Carson ladder. The interviewer would then move up the modified ladder asking for willingness to pay responses at each level of water quality. The neutrality or non-neutrality of the subjective indices could than be tested.

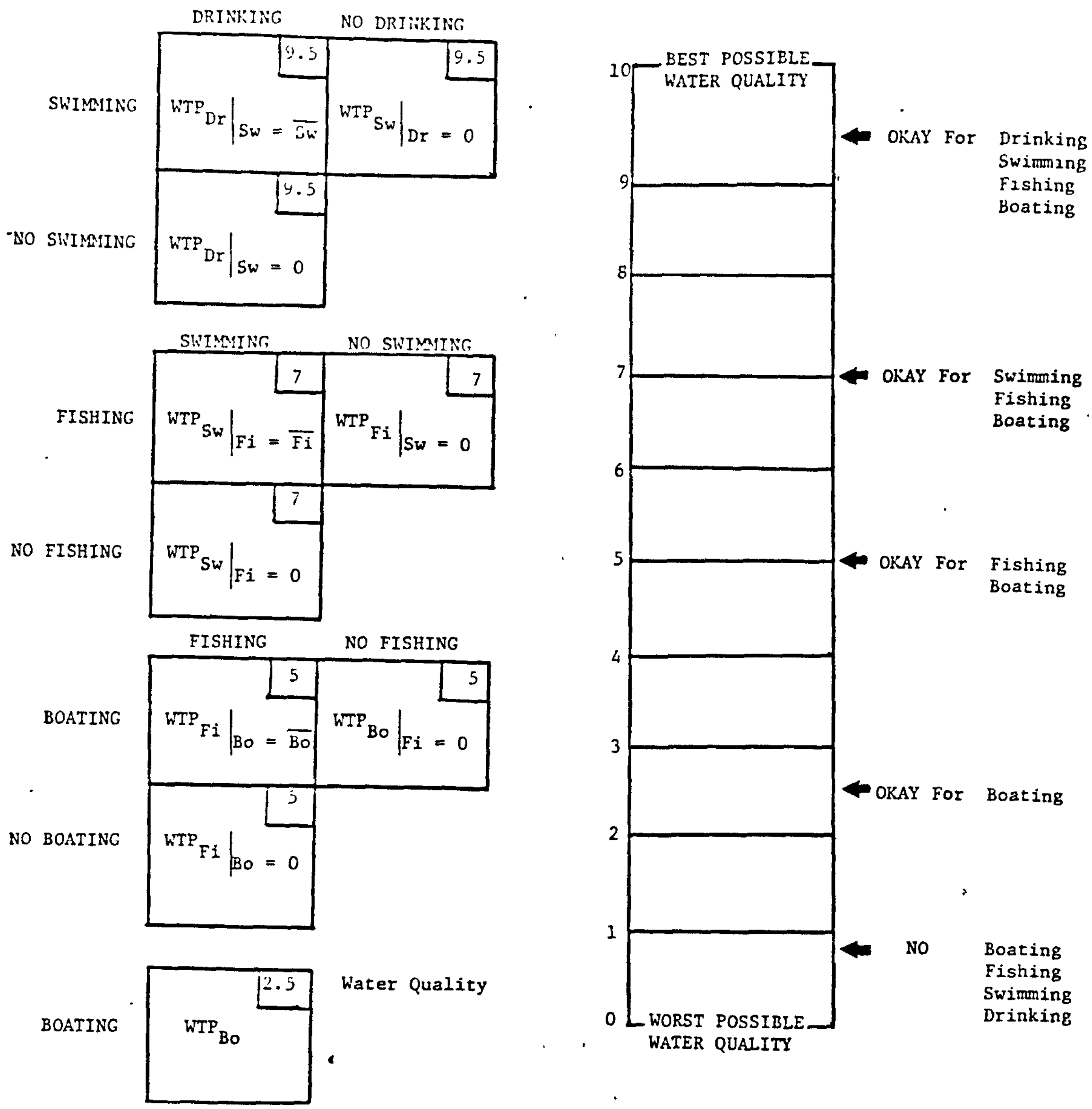

Figure 5. Modified Water Quality Ladder

The modified ladder asks the respondent to reveal 7 to 10 willingness to pay estimates (depending at which water quality level the interviewer stops). Comparatively, the Mitchell-Carson ladder only asks for 3 to 4 value responses. The additional pressure and time on the individual for more value responses may complicate the modified ladder possibly leading to biased estimates.

In the Okoboji experiment, several attempts were made to experiment with the modified ladder and also to test whether the various water based recreation activities identified on the ladder tended to be substitutes or complements. In Table 8, Appendix 3 are recorded how individual’s perceive whether these recreation activities are substitutes, complements, or neutral. With the exception of fishing and boating which was largely perceived as complemental, and drinking water with boating which were viewed as neutral, the other combinations were viewed more or less equally as substitutes, complements, and neutral. This observed result is suggestive, that indeed, substantial biases may occur using the standard water quality ladder unless individual differences in complementarity and substitution are taken into account.

The Okoboji Experiment

Data were collected on most recent sales of private residences on both East and West Okoboji Lakes. At the same time, data on characteristics of the residence sold were collected including: assessed valuation, replacement value (or cost), residence (square feet), number of rooms, number of bathrooms, lake frontage in feet, number of bedrooms, number of bathrooms, age of structure, existing garage or other buildings, existing basement, and other housing characteristics. Only residences actually located on one of the lakes were examined. That is, each residence selected for either the hedonic price comparison or for the limited survey of willingness to pay responses had some amount of actual lake frontage (actual frontage ranged from 33 to 150 lineal feet). Thus, only individuals who resided on the lakes were included in the survey, and for the hedonic price equation only residences on the lakes were included. By only including “residents” we omit consideration of individual’s who have been omitted because of higher prices and thereby have made alternative residence decisions. The problem of establishing a “chock” price does not arise as it does with travel cost models if our sample adequately reflects all dimensions of the resident population. Both lakes are also utilized by non-residents and residents without lake frontage. In order to assess their benefits, a separate analysis would need to be conducted utilizing a visitor day type method, most preferably some from it “generalized travel cost model” proposed by Smith, Desvousges, and Fisher (ref. 3). In this experiment we are only concerned with assessing the benefits of residents on the lakes themselves. A questionnaire was used to obtain willingness to pay estimates along with testing the modified water quality ladder described earlier. The complete questionnaire is listed in Appendix 1. Because of budget limitations, the length of the questionnaire, and limits to the sample from smallness of population, a sample size of twenty was decided upon. While this number is small, we felt that it was sufficient as a test for the hypotheses proposed and also to give insights into how useful the modified water quality ladder might be. (For each variant, less than 8 individuals are surveyed). Basic data were collected during the summer and fall of 1984 in the Okoboji Lakes region. The sample sizes for this experiment are relatively small, 20 for the contingent valuation survey, 66 for housing assessed valuation or sales, and 17 for realtor's responses. This accounted for approximately 10 percent of residences on the lakes in terms of property sales, 3 percent of the households in the contingent valuation survey, and 15 percent of the total realtors and real estates agents in the Okoboji area. Whether these are adequate samples to represent the area is unclear. Using a single power test suggests that sample size for the contingent valuation method should be 22 (with R^2 = .30, number of variables 5, and significance level .05,) (see ref. 2). For estimating precise benefits of water quality improvements rather than examining methodologies and experimental approaches, probably a larger sample would need to be taken for accuracy in application of the contingent valuation method.

For the sample derived from property that had sold in the last ten years, the assessed valuation per square foot on West Okoboji Lake (in 1983) was $75.15 and for East Okoboji Lake, $43.48. The average difference in housing square foot assessed valuation between the lakes was therefore, $31.67: One of the central questions focused on in this research is to what extent water quality contributed to this observed differential. According to the survey of realtors in the Okoboji area, water quality differences between the lakes accounted for about 46 percent of this difference. (See Appendix 2, Table 2). Neighborhood and social class effects accounted for the next largest percentage at 24 percent. Thus, from the realtor's perspective, the dominant factor affecting housing prices, when adjusted for square footage, was the known difference in water quality. If one takes 46 percent of $31.67, this is the Realtor's (averaged) estimate of the losses in valuation due to water quality, or $14.57 per square foot for lake front property. Note, we have used assessed valuation rather than reported sales prices in these computations. The reason was that there are likely to be substantial errors in reporting of sales prices for the Okoboji area both because of tax avoidance and the method of reporting. The raw correlation coefficient between assessed valuation and reported sales price was less than 0.25. Thus, a more accurate measure of "actual" selling price was thought to be assessed valuation. A third value, replacement value of buildings, was also employed for comparative purposes, and is reported along with the assessed valuation results whenever feasible. In general, replacement value, as would be expected, yielded a lower difference than assessed valuation between the two lakes. For the same sample, the difference in replacement value was $14.74 per square foot, and applying the Realtor's estimate (the proportion induced by water quality differences) one obtains a loss value of $6.78 per square foot in replacement value.

For some inexplicable reason, replacement value as a proportion of assessed valuation and water quality as such a proportion, are both about 46 percent!

Hedonic types of equations were estimated for the West and East

Lakes separately and a pooled regression was also estimated. These regressions are presented in summary form, in Tables 6, 7, and 8 in Appendix 3. For the individual equations, the age of house and feet of lake frontage were significant in the West Okoboji equation and housing square feet, total rooms, and feet of lake frontage were significant in the East Okoboji equation, at the 5 percent level. If we assume that lake frontage incorporates all attributes of water quality (this is extremely unlikely) then the difference in assessed valuation per foot of lake frontage should, in a crude way, reflect valuation differences between the lakes. This amounts to $1,009.00 per foot difference derived from the difference in regression coefficients. (Lake frontage averaged 62 feet on West Okoboji and 58 feet on East Okoboji.) This implies a valuation loss of $12.83 per square foot of dwelling using the average measures of lake front, housing square feet and Realtor’s proportions allocated to water quality. Without applying the Realtor’s proportion, we would be including socio-economic and other factors in the estimate based on lake frontage.

Another approach to estimating the hedonic price of water quality was to pool the data for East and West Lakes and compare the differences net of housing characteristics. The reported results are contained in Appendix 3, Table 8. For assessed valuation as a measure of price, the pooled regressions had significant coefficients for square feet of housing, age of house, feet of lake frontage, and most importantly, whether the property was located on East or West Okoboji. An $84,189 difference was observed net of basic housing characteristics. This amounts to a $39.12 per square foot difference, which is higher than the $31.67 actual average difference in the sample, but close enough to appear to be reasonable. The pooled regression equation does not contain socio-economic variables reflecting neighborhood effects, visual beauty of the site, etc. so in order to adjust for these factors, the gross difference in terms of the pooled regression must adjusted. Applying the 46 percent estimate by Realtor’s to the pooled regression yielded a square foot valuation of water quality of $13.58, which is very close to Realtor’s own best estimate. It is only slightly higher than the reported value from differences in lake frontage values. However, all three of these estimates are dependent on the Realtor’s average allocation of value to water quality attributes.

The final two measurements of the analysis are based on a limited application on the contingent valuation method. Both willingness to pay and willingness to be compensated measures of consumer surplus were elicited from a statistical random sample of residents at both lakes. The willingness to pay measure is equivalent to the compensating surplus measure of consumer surplus, since we are asking how much income the individual will give up (increased property taxes) to obtain a specified water quality improvement (see references 6 and 12). Alternatively, they were asked how much they would need in minimum compensation (reduced property taxes) to be as well off as before, with a symmetrical decrease in water quality, which is also a compensating surplus measure since utility is unchanged in either case. Neither of these measures is likely to coincide with equivalent surplus which almost undisputedly is the “best welfare measure of benefits (see ref.13). However, for commodities that enter regularly, if indirectly, in a market, such as water quality at the two lakes, we can presume they would be reasonably close (see ref. 14).

As was specified earlier in a summary of perceptions, the surveyed residents of East Okoboji perceived their water quality as being between C and B on the water quality ladder. That is, the lake is fishable and boatable but only occasionally swimmable. The residents of West Okoboji Lake perceived their lake as swimmable, fishable, and boatable, and to some extent, drinkable. Thus, for a willingness to pay measure, residents in East Okoboji are bidding from approximately B- to A and West Okoboji residents are bidding from B+ to A. However, this was partially sorted out in the regression equations by including a variable reflecting which lake the bid or compensation is from. Average bids across residents converted to housing value equivalents by using the average residence size on each lake and a 5 percent real rate of true discount or interest are recorded in Appendix 3, Table 9. The bids were requested in dollars per $1,000 assessed valuation in additional taxes per year or in reduced dollars per $1,000 assessed valuation in reduced taxes per year. Thus, the bids and compensation referenced the same units as the hedonic regression equations, which was fortuitous, given the observed inadequacy of the property sales data. The mean bid across both East and West Okoboji residents was $6.29 per $1,000 assessed valuation with average square footage being 1851. Thus, an average bid per square foot in present value terms for both lakes was:

$$\frac{(\text{Bid per } \$1{,}000)\ \begin{pmatrix}\text{Average Number of}\\ \text{Thousands of Assessed}\\ \text{Valuation}\end{pmatrix}}{(r)(\text{Average number of square feet})} = \frac{(6.29)(120.7)}{(.05)(1851)} = \$8.20 \quad (7)$$

This figure presumes the life of the house to be indefinitely large but the contribution to value beyond 100 years is marginally still at 5 percent. The average bid transformed using averages of assessed valuation and square footage of housing is $8.20 per square foot. The willingness to pay measure (compensating surplus) is estimated to be about 56 percent of the Realtor’s best estimate and about 60 percent of the traditional “hedonic” price derived from a pooled OLS regression equation. This is consistent with other researcher’s findings and the discussion earlier that the rental gradient should exceed to marginal willingness to pay (See ref. 10). There is also no significant difference, at the 5 percent level,between the imputed marginal willingness to pay (B to A) and imputed marginal willingness to accept compensation (B to C) across all residents sampled. However, this should not be taken to mean that there is no substantial difference in willingness to pay for an increase and willingness to accept for a decrease, because the compensation questions led to a greater than 60 percent refusal to be compensated. Whether this was due to questionnaire design or the inherent problems in eliciting responses for compensation is unclear. However, most non-respondents indicated a very large compensation initially or indicated that reduction in water quality was “totally unacceptable”, “ungodlike”, or something harmful enough to call in the “National Guard”. Most of the non-respondents were from the West

TABLE 2. COMPARISON OF VALUATION RESULTS

Estimate derived from	Difference in value per square foot of housing	Percent of Observed Average Housing Value	Percent of of Realtor's Estimate
	(1983 $ per square foot)	(Percent)	(Percent)
Realtor's Best Estimate	14.57	23	0
Imputed Value From Regression on Lake Frontage*	12.83	20	88
Pooled Regression Estimate Coupled with Realtor's Valuation	13.58	21	93
Imputed Willingness to Pay (Average across lakes)	8.20	13	56
Imputed Willingness to Accept Compensation (Average across lakes)	4.34	7	30

*Adjusted for realtor's proportion attributed to water quality.

Lake, while individuals from the East Lake were more prone to provide an estimate. Thus, even though an average adjusted compensation of $4.34 per square foot is given in Table 2, it is unlikely that this estimate represents an accurate one. The true estimate is probably several times this one if it were accurately obtained from the respondents. Note, however that the magnitudes of compensation is not consistent with hypothesis 1 established earlier. Compensation is less than either the estimated rent gradient or willingness to pay which is exactly the reverse of hypothesis 1.

From Table 2, it can be seen that marginal willingness to pay is less than the rental gradient, as is predicted by theory, but not substantially so. For the Los Angeles experiment, marginal willingness to pay was only 34 percent of the rent gradient estimate for the sample (See ref. 10). Also, the three estimates of the rental gradient are reasonably close together with the Realtor's estimate being the highest. This might be anticipated "ex ante", since Realtor's would have a strategic incentive to overvalue characteristics of the commodity they are selling. Second, ex ante, we should anticipate these estimates to be relatively close, given that the "commodity" is well defined to residents and has been for at least 30 years. In consequence, unlike air pollution in Los Angeles, residents in the Lake Okoboji area have had a very long history of experience with a distinct and identifiable water quality difference which has not varied substantially over many years.

In Table 9 of Appendix 3 are recorded the bids and compensation by location of lake residence and weighted by average residence size and assessed valuation. Because of the small number of observations, these average estimates must be viewed only as illustrations of the magnitudes of marginal compensation and willingness to pay but not as definitive and precise measures. However, several very tentative observations can be made. First, the average marginal willingness to pay for improved water quality by West Okoboji residents exceeds that for East Okoboji residents. This would be expected since West Okoboji residents have paid more via the rent gradient for higher water quality. The difference between the two is very small, on the order of 4 percent. It can be argued that this result should also be observed. If residents of the cleaner lake were willing to pay much less at the margin for cleaner water than those of the less clean lake, we would expect some degree of relocation between lakes which, according to Realtors, has not occurred. Also, observed willingness to be compensated is substantially higher for East Okoboji residents than for those on the West Lake which is consistent with the concept of diminishing marginal utility. However, the magnitude of compensation is less than marginal willingness to pay for both lakes which makes no sense from the standpoint of diminishing marginal utility, and is probably indicative that the compensation measures are biased downward as was expected given the replies of the respondents discussed earlier.

An ordinary least squares regression was applied to the limited sample derived from the contingent valuation experiment. The results are reported in Appendix 3, Table 6. The income variable was not significant at any reasonable significance level for willingness to pay or willingness to be compensated. Neither were the measures of satisfaction with existing lake water quality significant at the five percent level. However, the East compared with West variable was significant. For the compensation measure, all the signs of the coefficients indicated that East Lake residents willingness to pay and compensation were uniformly lower than West Lake Okoboji residents, as was reflected in comparison of the averages for willingness to pay but not for compensation measures (compare Appendix 3, Table 10).

With regard to the preliminary experiments on the water quality ladder, some results are presented in Appendix 3, Tables 12 and 13. Most individuals responded to identifying whether various water based recreation activities were neutral, substitutes, or complements to them personally. Fishing and boating were highly complemental, while potable water and boating were strongly neutral. It appears the pairs of swimming/fishing, drinking/swimming, and swimming/boating were either complements, substitutes, or neutral depending on the individual. These results are suggestive that as one moves up the water quality ladder, there is at first complementarity (between fishing/boating), then substitution (between swimming/fishing), and finally, either complementarity or neutrality (between drinking/swimming or swimming/boating). Bids across activity pairs tended to indicate greater neutrality across activities than the questions on identification of how individuals compare pairs of activities. However, the preliminary results identified in Table 12 are suggestive that the assumption of neutrality in applications of the water quality ladder needs to be either verified through repeated trials or that modifications must occur prior to it's use for adequate benefits estimates to be forthcoming.

Interpretation of Results

Five hypotheses were proposed in the earlier part of this paper. The first indicated that marginal willingness to pay should be observed to be less than the rental gradient and this was the case, for all measurements of the rental gradient. However, the second part of the hypothesis proposed that the marginal compensation measure should exceed the rental gradient. This was not observed. However, because of resistance by residents at both lakes to accept compensation, it cannot be concluded that any adequate test of this part of the hypothesis was indeed accomplished.

The second hypothesis was that if individual sales influenced real estate prices, that the actual rental gradient would be steeper than one based on a hedonic estimate. If we take the Realtor's best estimate as the most likely to be close to the actual rental gradient and compare it with the hedonic estimate, we observe then in fact the hypothesis is accepted. That is, the hedonic measure of water quality is less than the Realtor's best estimate. Whether this observation will continue if a true marginal estimate from Realtor's was obtained cannot be ascertained given the evidence at hand. Thus, hypothesis 2 is accepted, but with substantial caution. Hypothesis 3 was the mirror image of hypothesis 2 for water quality reductions. Since such reductions have not occurred historically, we are unable to make inferences from the results as to it’s probable outcome.

Hypothesis 4 that marginal willingness to pay of West Okoboji residents would exceed that of East Okoboji residents was observed, both in higher taxes and imputed willingness to pay on housing per square foot basis. Thus, this hypothesis appears to be substantially confirmed. The reverse of this hypothesis with respect to magnitude of willingness to be compensated is not supported by the findings of this experiment, but again, may be due to the unreliability of responses to compensation questions.

The fifth hypothesis on rent gradients being substantially different between the two lakes was observed utilizing three distinct methods of estimation. The first was by solicitation of estimates from realtors. The second was through imputation of differences in the value of lake frontage between lakes, and the third imputed from the results derived from a pooled regression across both lakes. All of these measures were reasonably close together which would be expected, ex ante, where water quality had become an accepted and valued commodity.

From the preliminary results on water quality ladders, we cannot say that substitution and/or complementarity between water based recreation activities will seriously bias benefit estimates derived from the ladder. This experiment has yielded some evidence to suggest that such bias may be a serious problem and that it would be worthwhile to conduct further research on this potential source of bias.

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APPENDIX 1

Lake Okoboji Survey Questionnaire
Preliminary Water Quality Data

1. Your cabin (house) is on: _____ West Okoboji _____ East Okoboji

2. How long have you owned your cabin (house)? __________ years

3. Do you live here full time? _____ yes _____ no

If no: a. How many months or weeks annually do you live here?
_____ months _____ weeks
b. Distance from cabin to home: _____ miles

4. How often do you participate in the following activities?

Activity	Never (0 day/yr)	Rarely (1-5 day/yr)	Occasionally (5-15 day/yr)	Often (more than 15 days/yr)
Swimming	_____	_____	_____	_____
Boating:				
Sailing	_____	_____	_____	_____
Canoeing	_____	_____	_____	_____
Motor boating	_____	_____	_____	_____
Fishing	_____	_____	_____	_____

5. Please try to estimate your activity participation more specifically:

Activity	Avg. days per week	Avg. hour per day
Swimming	__________	__________
Boating:		
Sailing	__________	__________
Canoeing	__________	__________
Motor boating	__________	__________
Fishing	__________	__________

6. When participating in water activities, where do you spend more time?

	Lake	
Swimming	_____ East	_____ West
Boating:		
Sailing	_____ East	_____ West
Canoeing	_____ East	_____ West
Motor boating	_____ East	_____ West
Fishing	_____ East	_____ West

In 1972 and 1977, Congress passed laws to improve the nations water quality. These programs have resulted in cleaner lakes that are better places for boating, swimming, fishing, and other outdoor activities.

In this study we are concerned with the water quality of only East and West Lake Okoboji.

7. In general, how satisfied are you with the water quality of:

a. West Okoboji -

1. Very satisfied
2. Satisfied
3. Neutral
4. Dissatisfied
5. Very dissatisfied

b. East Okoboji -

1. Very satisfied
2. Satisfied
3. Neutral
4. Dissatisfied
5. Very dissatisfied

8. Have you (ever) noticed a difference in water quality between East and West Okoboji? _____ yes _____ no
If yes, please check physical difference(s) you have noticed:
_____ Odor _____ Color _____ Algae growth _____ Taste
_____ Other

9. a. Have you avoided using East or West Okoboji due to water quality?
_____ yes _____ no
If yes, why? _____ Odor _____ Dirty water (color) _____ Algea growth
_____ Taste _____ Other
b. Have you avoided using East Okoboji due to water Quality? _____ yes
_____ no
If yes, why? _____ Odor _____ Dirty water (color) _____ Algea growth
_____ Taste _____ Other

10. Are there other reasons beside water quality why you substitute one lake for another? _____ yes _____ no
If yes, why? _____ Friends/relatives _____ Resorts _____ Beaches
_______________________________ Other (please specify)

Now consider water quality and your choice of buying a cabin (home).

11. Was the water quality of Okoboji a major consideration when choosing your cabin (home)? _____ yes _____ no

12. Please rank (1-6) in order of importance (1-most important, 6-least important) regarding your decision to purchase a cabin (home) on Okoboji.
_____ Price _____ Location _____ Water quality _____ Friends/relatives
_____ Resorts _____ Other

13. Has the water quality of Lake Okoboji affected your decision to stay in your present cabin (home)? _____ yes _____ no

Resident Water Quality Perception

I. Water Quality Ladder and Anchoring Level

Water quality improvements on Lake Okoboji, represent benefits to users of the lake, East arid West. Generally, the better the water quality, the better the water for outdoor activities (i.e., boating, fishing, swimming).

The different levels of water quality are presented by the water quality ladder below.

Best water quality	10	A	Drinkable, swimable, fishable, boatable
	9		
	8		
	7	B	Swimmable, fishable, boatable
	6		
	5	C	Fishable, boatable
	4		
	3	D	Boatable
	2		
	1	E	No activity recommended
Worst water quality	0		

Examining the water quality ladder, you can see that 0 (bottom) is the worst possible water quality and 10 (top) is the best possible water quality. Now consider the water quality levels A, B, C, D and E.

Level E: So polluted that no plant or animal life exists, it smells bad, and it has oil, raw sewage, trash, etc.

Level D: Okay for boating but not fishing or swimming.

Level C: Water is clean enough to support game fish (ex. Bass).

Level B: Water is suitable for swimming.

Level A: Water is so clean that people can drink directly from the lake.

For example, water quality level D implies that boating is the only recommended activity. Water quality level B indicates that swimming, fishing and/or boating can be recommended. Also notice that once an activity is recommended, it can continue to be done at higher levels on the water quality ladder.

Q. la a. Consider the water quality of East Okoboji on the whole. In terms of this scale from A to E, how would you typically rate the water quality of East Okoboji?

E D C B A Z East

Don’t know

b. How would you typically rate the water quality of West Okoboji?

E D C B A Z West

Don’t know

Resident Water Quality Perception

I. Water Quality Ladder & Anchoring Level

Water quality improvements on Lake Okoboji represent benefits to users of the lake, East and West. Generally, the better the water quality, the better the water for outdoor activities (i.e., boating, fishing, swimming).

The different levels of water quality are presented by the water quality ladder below.

Best water quality	10	A	All Activities Recommended
	9		
	8		
	7	B	Not Drinkable
	6		
	5	C	Not Drinkable, Swimmable
	4		
	3	D	Not Drinkable, Swimmable, Fishable
	2		
	1	E	Not Drinkable, Swimmable, Fishable, Boatable
Worst water quality	0		

Examining the water quality ladder, you can see that 0 (bottom) is the worst possible water quality and 10 (top) is the best possible water quality. Now consider the water quality levels A, B, C, D, and E.

Level E: No Activity can be recommended

Level D: Water Quality is not suitable for drinking, swimming, or fishing

Level C: Water Quality is not suitable for drinking or swimming

Level B: Water Quality is not suitable for drinking

Level A: All Activities can be recommended

For example, water quality level D implies that the drinking, swimming, or fishing can not be recommended. Water quality level B indicates that drinking the water can not be recommended.

Q. 1a a. Consider the water quality of East Okoboji on the whole. In terms of this scale from A to E, how would you typically rate the water quality of East Okoboji?

E D C B A

Don't know Z East

b. How would you typically rate the water quality of West Okoboji?

E D C B A

Don't know Z West

Note to Interviewer: Be sure to emphasize “standard summer season” to the surveyee.

Q. 2a Now,

a. Consider a standard summer season of 100 days. [Memorial day to Labor day] Below, each level (A-E) on the water quality ladder is listed. Please attempt to estimate how many days the water quality of East Okoboji is at:

Level E _____Days
Level D _____Days
Level C _____Days
Level B _____Days
Level A _____Days
100 Total days

b. How many days (again out of 100) is the water quality of West Okoboji at:

Level E _____Days
Level D _____Days
Level C _____Days
Level B _____Days
Level A _____Days
100 Total days

II. Willingness to pay - Compensating vs. Equivalent Variation

Consider the costs of water quality improvements. In order to clean up a lake, we contribute directly through our tax dollars, especially our property tax dollars. We also pay for water quality improvements through sewage treatment, cesspool installation, monitoring possible lake pollutants, etc. I want to ask what amount of money you would be willing to pay each year for different levels of water quality. I also want to ask how much money you would be willing to accept [in lower property tax] for different levels of water quality. Remember the amount you pay or receive each year would be paid in the form of higher or lower property taxes. The taxes will be put in a clean up fund for Okoboji. They will not go into the General Tax Fund. Also keep in mind the recreation activities that you engage in.

Payment Card

The payment card shows different yearly amounts people might be willing to pay (accept) through higher (lower)- property taxes for different levels of water quality. You can use this card to help you answer the questions.

I will ask you two different sets of WTP questions with slightly different approaches. If you.have questions or are confused at any time please feel free to stop and ask.

A. Compensating Variation

Note to Interviewer: Start the WTP at the water quality level the surveyee chooses in Q.1a. for his/her resident lake.

Fill in 0.1a Response: Level ______

If Q.1a is:

Level E, then surveyee answers Q.1b-Q.4b
Level D, then surveyee answers Q.1b-Q.3b, Q.5b
Level C, then surveyee answers Q.1b, Q.2b, Q.5b, Q.6b
Level B, then surveyee answers Q.1b, Q.5b-Q.7b
Level A, then surveyee answers Q.5b-Q.8b
Level Z, (don't know) then start surveyee at Level B

Interviewer: Simplify your job: please circle the questions (Q.1b-Q.8b) that the surveyee will answer given Q.1a.

Now, let's begin the first set of WTP/WTA questions

WTP

Q. 1b What is the most you and your family would be willing to pay on a yearly basis to improve the water quality from Level ____ (Q.1a) to Level ______ (one level above Q.1a)? $______________________

Q. 2b (In addition to the amount you must told me) what is the most you would be willing to pay each year to improve the water quality from Level ______ to Level (two levels above Q.1a)? $__________________

Q. 3b How much more would you be willing to pay each year to improve water quality from Level _ (two levels above Q.1a) to Level _ (three levels above Q.1a)? $__________________

Q. 4b How much more would you be willing to pay each year to improve water quality form Level _ (three levels above Q.1a) to Level_ (four levels above Q.1a)? $__________________

WTA

Q. 5b What would you be willing to accept each year in reduced property taxes to lower the water quality from Level ___ (Q.1a) to Level _ (one level below Q.1a)? $____________________

Q. 6b What would you be willing to accept each year to lower the water quality from Level (one level below Q.1a) to Level _ (two levels below Q.1a)? $__________________

Q. 7b What would you be willing to accept each year to lower the water quality from Level (two levels below Q. la) to Level _ (three levels below Q.1a)? $ —

Q. 8b What would you be willing to accept each year to lower the water quality from Level (three levels below Q.1a) to Level (four levels below Q.1a? $ —

Q. 9b If you answered $0 to Q-1 through Q-8, do you believe that:

a. Water quality is not a problem for your family? ________
b. Water quality cannot be valued. ________
c. Not enough information ________

d. That is what it is worth ________
e. Other ________ (please specify) Equivalent Variation

Note to Interviewer: Fill in Q.1a Response: Level ______

If Q.1a is:

Level E, then surveyee answers Q.14b-Q.17b
Level D, then surveyee answers Q.10b, Q.14b-Q.16b
Level C, then surveyee answers Q.10b, Q.11b, Q.14b, Q.15b
Level B, then surveyee answers Q.10b-Q.12b, Q.14b
Level A, then surveyee answers Q.10b-Q.13b
Level Z (don't know), then start surveyee at Level B

Again, circle questions surveyee should answer

Now, let's start the second set of WTP/WTA questions

WTP

Q. 10b What is the most you and your family would be willing to pay on a yearly basis in higher property taxes to keep the water quality from decreasing from Level (Q.1a) to Level___ (one level -below Q.1a)? $_______________

Q. 11b What is the most you would be willing to pay each year in higher property taxes to keep the water quality from decreasing from Level ___ (Q.1a) to Level (two levels below Q.1a)? $___________________

Q. 12b What is the most you would be willing to pay each year to keep the water quality from decreasing from Level_____(Q.1a) to Level _____(three levels below Q.1a)? $_________________

Q. 13b What is the most You would be willing to pay each year to keep the water quality from decreasing from Level_____(Q.1a) to Level_____(four levels below Q.1a)? $_____________________

WTA

Interviewer: Scenario: The county has enough money to increase the water quality of the lake, but instead is going to redistribute the money back to the property taxpayers by reducing property taxes.

Q. 14b What would you and your family be willing to accept each year in lower property tax to remain at Level (Q.1a) instead of increasing to Level _ (one level above Q.1a)? $ –________________

Q. 15b What would you and your family be willing to accept each year in lower property tax to remain at Level (Q.1a) instead of increasing to Level (two levels above Q.1a)? $ –_______________

Q. 16b What would you and your family be willing to accept each year in lower property tax to remain at Level __(Q.1a) instead of increasing to Level (three levels above Q.1a)? $_______________________

Q. 17b What would you and your family be willing to accept each year in lower property tax to remain at Level (Q.1a) instead of increasing to Level (four levels above Q.1a)? $______________________

Q. 18b If you answered $0 to Q.10b - Q.17b do you believe that:

a. Water quality is not a problem for your family ________
b. Water quality can not be valued ________
c. Not enough information ________
d. That is what it is worth ________
e. Other ________ please specify ______________________________

III. Willingness to Pay - Substitutes, Complements, or Neutral

Lets consider the Water Quality Ladder again. Using the same payment/property tax card, I will again ask for your WTP for changes in the level of water quality.

We are also going to interject some hypothetical situations into the water quality evaluation. We will start by saying Okoboji is at water quality level D, the water is only recommended for boating. Then we will move up the ladder, asking for your WTP for different situations. These hypothetical situations depend upon the characteristics of the subjective indices, ex. boating, fishing, swimming. These situations may seem confusing at first so please feel free to ask questions. Each WTP for an improvement in water quality will consist of three questions.

For example:
Given we are at Level D (boatable), what is your WTP to improve water quality to level C (fishable) where:

1. Fishing and boating are both allowed? $______ (previous bid amount)
2. Only fishing is allowed? $________________
3. Only boating is allowed? $________________

Examples #1 Boat fisherman
#2 Shore fisherman
#3 Water skiiers

Now using your tax reference sheet and the water quality ladder let's examine your WTP for water quality improvements. Remember the activities you participate in and also that each bid amount is in addition to the amounts previously bid.

Note to Interviewer: Start the WTP responses at water level D.

Now, let's begin the WTP questions.'"

WTP

Q. 1c What is the most you and your family would be willing to pay each year by higher taxes to improve water quality from Level D to Level C where:

a. Boating and Fishing are allowed?
$______________________ [Fill in amount given in Q.1b]
b. only Boating is allowed? $ ____________________
c. only Fishing is allowed? $ ____________________

Q. 2c In addition to the amount you just told me, what is the most you would be willing to pay each year to raise the water quality from Level C to Level B where (please note that each hypothetical situation (1-3) are separate bids):

a. ___Fishing___ and ___Swimming___ are allowed? $________________
[Fill in bid from Q.2b]

b. only ___Fishing___ is allowed? $ ________________

c. only ___Swimming___ is allowed? $ ________________

Q. 3c How much more would you be willing to pay each year to raise water quality from Level B to Level A where:

a. ___Swimming___ and ___Drinking___ are allowed?
$________________ [Fill in bid from Q.3b]

b. only ___Swimming___ is allowed? $ ________________

c. only ___Drinking___ is allowed? $ ________________

IV. Substitutes and Complements - Check List

Note to Interviewer: This section is to test for the perceived existence of substitutability, complementarity or neutrality of the subjective index activities (i.e., boating, fishing, swimming, drinking). The interviewer will ask the surveyee how they perceive the activities. This section will then be compared to Section III (Willingness to pay/substitutes, complements or neutral) and tested for compatibility.

Q. 1d I will list the following activities and you tell me if you perceive them as complements, substitutes, or neutral activities. For example:

Complementary goods are two goods that are used together, example bread and butter or car and gas. Another example is if you like to fish from a boat, then fishing and boating are complements.

Substitute goods are two goods that can be substituted for one another, example beef and pork, or books and TV. Another example is if you like to fish from the shore, then fishing and boating are substitutes.

Neutral goods are two goods that do not affect how much the other good is used, for example listening to your radio and eating fruit.

Now lets examine the following activities for complementarity, substitutability, or neutrality.

Activities	Complements	Substitutes	Neutral
Fishing & boating	____	____	____
Swimming & fishing	____	____	____
Drinking & swimming	____	____	____
Swimming & boating	____	____	____
Drinking & boating	____	____	____
	____	____	____

b. East Okoboji -
1. Very satisfied
2. Satisfied
3. Neutral
4. Dissatisfied
5. Very dissatisfied

8. Have you (ever) noticed a difference in water quality between East and West Okoboji? ______ yes ______ no

If yes, please check physical difference(s) you have noticed:

_______ Odor
_______ Color
_______ Algae growth
_______ Taste
_______ Other

9. a. Have you avoided using West Okoboji due to water quality?
_______ yes _______ no
b. Have you avoided using East Okoboji due to water Quality?
_____ yes _______ no
If yes, why?

_______ Odor
_______ Dirty water (color)
_______ Algae growth
_______ Taste
_______ Other

10. Are there other reasons beside water quality why you substitute one lake for another? _______ yes _______ no
If yes, why?

_______ Friends/relatives
_______ Resorts
_______ Beaches
____ Other (please specify)

Now consider water quality and your choice of buying a cabin (home).

11. Was the water quality of Okoboji a major consideration when choosing your cabin (home)? _______ yes _______ no

12. Please rank (1-6) in order of importance (1-most important, 6-least important) regarding your decision to purchase a cabin (home) on Okoboji.

_______ Price
_______ Location
_______ Water quality
_______ Friends/relatives
_______ Resorts
_______ Other

13. Has the water quality of Lake Okoboji affected your decision to stay in your present cabin (home)? _____ yes _______ no

Level D Start

Q. 1C What is the most you and your family would be willing to pay each year by higher taxes to keep water quality from slipping from Level D to Level E? $ ___________ Q. 2C In addition to the amount you just told me, what is the most you would be willing to pay each year to raise the water quality from Level D (boatable) to Level C (fishable) where (please note that each hypothetical situation (1-3) are separate bids):

1. Fishing and boating are both allowed? $ _____
2. Only boating is allowed? $ _____
3. Only fishing is allowed? $ _____

Q. 3c How much more would you be willing to pay each year to raise water quality from Level C (fishable) to Level B (swimable) where:

1. Swimming and fishing are both allowed? $ ______
2. Only fishing is allowed? $ ______
3. Only swimming is allowed? $ ______

Level B Start

Now lets start at a different water quality level, Level B (swimable), and start the bidding process again.

Q. 4c What would you be willing to pay each year in higher property taxes to keep the water quality from slipping from Level B (swimable) to Level C (fishable) where:

1. Both fishing and boating are allowed? $ ______
2. Only fishing is allowed? $ ______
3. Only boating is allowed? $ ______

Q. 5c In addition, what would you be willing to pay each year to improve the water quality from Level B (swimable) to Level A (drinkable) where:

1. Drinking and swimming are both allowed? $ ______
2. Only swimming is allowed? $ ______
3. Only drinking is allowed? $ ______

Q. 6c Again, if you answered zero ($0) to Q1-Q5, why?

a. Water quality is not a problem for your family. ______
b. The victim should not be forced to pay for cost of preventing damages. ______
c. Water quality cannot be valued. ______
d. Not enough information. ______
e. That is what it is worth. ______
f. Other ______ (please specify) ____________________________

IV. Substitutes and Complements - Check List

Note to Interviewer: This section is to test for the perceived existence of substitutability, complementarily, or neutrality of the subjective index activities (i.e., boating, fishing, swimming, drinking). The interviewer will ask the surveyee how they perceive the activities. This section will then be compared to Section III (Willingness to pay/substitutes, complements or neutral) and tested for compatibility.

Q. 1d I will list the following activities and you tell me if you perceive them as complements, substitutes, or neutral activities. For example:

Complementary goods are two goods that are used together, example bread and butter or car and gas. Another example is if you like to fish from a boat, then fishing and boating are complements.

Substitute goods are two. goods that can be substituted for one another, example beef and pork, or books and TV. Another example is if you like to fish from the shore, then fishing and boating are substitutes.

Neutral goods are two goods that do not affect how much the other good is used, for example listening to your radio and eating fruit.

Now lets examine the following activities for complementarily, substitutability, or neutrality.

Activities	Complements	Substitutes	Neutral
Fishing & boating	____	____	____
Swimming & fishing	____	____	____
Drinking & swimming	____	____	____
Swimming & boating	____	____	____
Drinking & boating	____	____	____

Personal Fact Sheet

1. What is your age? ____________ years

2. Sex: ____________ Male ____________ Female

3. Race:
   a. Black
   b. Oriental
   c. Hispanic or person of Mexican decent
   d. White
   e. Other (please specify) __________________

4. Level of Education
   a. Under 12 years ______
   b. High School ______
   c. College - no degree ______
   d. Trade School ______
   e. Bachelors degree ______
   f. Post-graduate degree ______

5. How many members are there in your household? __________________ persons

6. Please indicate which group includes your households annual before tax income.

   ______ less than $5,000
   ______ $5,000-9,999
   ______ $10,000-14,999
   ______ $15,000-19,999
   ______ $20,000-24,999
   ______ $25,000-29,999
   ______ $30,000-34,999
   ______ $35,000-39,999
   ______ $40,000-44,999
   ______ $45,000-49,999
   ______ $50,000-54,999
   ______ $55,000-59,999
   ______ $60,000-64,999
   ______ $65,000-69,999
   ______ $70,000-74,999
   ______ $75,000 and up

7. Which of the following best describes your present status?

   a. Employed full time ______
   b. Employed part time ______
   c. Retired ______
   d. Not employed ______
   e. Housewife ______
   f. Student ______
   g. Other (please specify) ______

8. If you are employed full or part time, what locale are you employed?

   ______ Locally ______ 100 mile radias ______ In the state (Iowa)
   ______ Regionally

APPENDIX 2

Realtor's Correlation Matrix and Results

I. Definition of Variables

Brok: Licensed broker = 1, licensed sales agent = 0

YRS: Number of years selling real estate in vicinity and/or at other locations

WQ: 1984 dollar allocation per square foot of structure (present value) for improved water quality

BA: 1984 dollar allocation per square foot of structure (present value) for beach access

RA: 1984 dollar allocation per square foot of structure (present value) for road access

NT: 1984 dollar allocation per square foot of structure (present value) for nearness to town

SC: 1984 dollar allocation per square foot of structure (present value) for social class/quality of neighborhood

VB: 1984 dollar allocation per square foot of structure (present value) for visual beauty

SE: 1984 dollar allocation per square foot of structure (present value) for seclusion

WA: 1984 dollar allocation per square foot of structure (present value) for availability of water related activities at the site

OTH: 1984 dollar allocation per square foot of structure (present value) for other factors

TABLE 3 RAW CORRELATION MATRIX BETWEEN VARIABLE FOR REALTOR'S

	BROK	YRS	WQ	BA	RA	NT
BROK	1.00000	.539183	.176935	.397276E-02	-.162196	-.248609
YRS	.539183	1.00000	.337855	-.714623E-01	.331762	-.385489
WQ	.176935	.337855	1.00000	0.167200	-.135859E-01	-.362026
BA	-.397276E-02	-.714623E-01	-.167200	1.00000	-.140783	-.362026
RA	-.162196	.331762	-.135859E-01	-.140783	1.00000	-.162975E-01
NT	-.248609	-.385489	-.362026	-.669774E-01	-.162975E-01	1.00000
SC	.387398	.510182E-01	-.493683	-.111019	-.271468	-.277977
VB	-.329063E-01	.638515E-01	-.640436	.947971E-01	.719349E-01	-.293530
SE	-.229068	-.247603	-.323141	.138325	.207037	.974743E-01
WA	-.336694	-.423875	-.139394	-.402793	-.618135E-01	.606510
OTH	-.235702	-.811191E-01	.159571	.412947	-.118645	-.919847E-01

	SC	VB	SE	WA	OTH
BROK	.387398	-.329063E-01	-.229068	-.336694	-.235702
YRS	.510182E-01	.638515E-01	-.247603	-.423875	-.811191E-01
WQ	-.493683	-.640436	-.323141	-.139394	.159571
BA	-.111019	.947971E-01	.138325	-.402793	.412947
RA	-.271468	.719349E-01	.207037	-.618135E-01	-.118645
NT	-.277977	-.293530	.964743E-01	.606510	-.919847E-01
SC	1.00000	.533769	-.587385E-01	-.374991	-.241296
VB	.533769	1.00000	.990679E-01	-.260283	-.284205
SE	-.587385E-01	.990679E-01	1.00000	-.675109E-01	-.129580
WA	-.374991	-.260283	-.675109E-01	1.00000	-.259431
OTH	-.241296	-.284205	-.129580	-.675109E-01	1.00000

Table 3 continued

Realtors Prorating Response Sheet

We (the Department of Economics, University of Wyoming) have determined that the mean property value per square foot of a cabin on East and West Lake Okoboji are:

West Lake Okoboji:	$80.75
East Lake Okoboji:	$44.75

The difference between East and West Okoboji: $36.00
[$80.75 - $44.75 = $36.00]

In order to assess why there is this difference in the mean property value per square foot, we are asking realtors to prorate (in percentages) this difference in terms of the following factors.

1.	Water Quality	$ ______
2.	Beach Access	$ ______
3.	Road Access	$ ______
4.	Nearness to town	$ ______
5.	Neighborhood/Social Class	$ ______
6.	Visual Beauty	$ ______
7.	Seclusion	$ ______
8.	Water Activities	$ ______
9.	Other (Please specify)	
	a. ______	$ ______
	b. ______	$ ______
	c. ______	$ ______
10.	Total (should total up to $36.00)	$ 36.00

III. Description of Results

The raw correlation matrix indicates that realtor's in the Okoboji area perceive some significant effects on housing prices other than water quality, especially social class, miles to town, and scenic beauty. They tended to increase the share of value allocated to these substantially when decreasing the share to water quality. Thus, there appears to be some substitution between very broad attributes associated with a site in that some realtors place a greater emphasis on characteristics other than water quality in establishing site value and they are negatively related. Interestingly, the longer the realtor was in real estate, the more value that was placed on water quality. Most of the signs between attributes were negative indicating that if a real estate person valued one attribute more highly in dollar terms, he tended to value others less.

TABLE 4

Realtor's Prorated Response Data

	Broker 8 respondents		Agent 9 respondents		Total 17 respondents			
	Total	Average	Total	Average	Total	Average	High	Low
Years	122.5	15.31	77.5	8.6	200	11.76	27	1
Water Quality	140	17.5	139.8	15.53	279.8	16.46	28.8	8
Neighborhood social class	82	10.25	65.6	7.29	147.6	8.68	16	3.6
Beach Access	17	2.125	19	2.11	36	2.12	5	0
Road Access	3	.375	7	.78	10	.59	5	0
Nearness to town	2	.25	13	1.44	15	.88	10	0
Visual Beauty	26	3.25	31	3.44	57	3.35	10	0
Water Activity	15	1.875	33.6	3.73	48.6	2.86	10	0
Seclusion	3	.375	9	1	12	.71	5	0
Other	0	0 $36	6	.67 $36	6	.35 $36	6	0

APPENDIX 3

Okoboji Survey and Property Value Results

I. Definition of Variables

WTPA - Amount the individual would be willing to pay (in higher property taxes) per year for a designated improvement in water quality

WTP B - Amount the individual would accept in compensation (in lower property taxes) per year for a designated small reduction in water quality

WTP C - Amount the individual would accept in compensation (lower property taxes) per year for a designated large reduction in water quality

EOW - East or West Okoboji Lake; 1= East, 0 = West

YR - Number of years resided at the lake

HUS - House size by visual inspection; 0 = small, 1 = medium, 2 = large

SAT W - Perceived level of water quality, West Okoboji

SAT E - Perceived level of water qualtiy, East Okoboji

DIFF - Perceived difference in water quality

DAY W - Number of days at perceived water quality level West Okoboji

DAY E - Number of days at perceived water quality level East Okoboji

NACT - Number of water based activities the individual participates in

RECDAY - Average recreation days per week

RECHR - Average recreation hours per week

AGEE - Age of the individual being interviewed

INCOME - Household annual income before taxes

TYPE A - Water activities are: 0 = neutral, 1 = complements, 2 = substitutes; applying bid response

TYPE B - Water activities are: 0 = neutral, 1 = complements, 2 = substitutes; applying actual response on data

TABLE 5
Raw Correlation Matrix For Willingness to Pay Data

	WTPA	WTPB	WTPC	EOW	YR
WTPA	1.00000	.894123	.918589	-.359566	-.206338
WTPB	.894123	1.00000	.970340	-.396873	-.769461E-01
WTPC	.918589	.970340	.1.00000	-.361547	-.127007
EOW	-.359566	-.396873	-.361547	1.00000	.198741
YR	-.206338	-.769462E-01	-.127007	.198741	1.00000
HUS	-.344951	-.842726E-01	-.157969	0.	.234197
SATW	.272614	.229177	.288164	.102062	-.058877E-01
SATE	-.387680E-01	-.120864	-.176131	.251577	-.128785
DIFF	-.255243	-.218185	-.306207	.223831	.318939
DAYW	-.768800E-01	-.139507	-.837469E-02	0.	-.398351E-01
DAYE	.235666	.276877	.309793	-.605718	-.650408E-01
NACT	.286516	.394567	.430566	-.843259E-15	-.650408E-01
RECDAY	-.853894E-01	-.120806	-.719386E-01	.349413	-.171888
RECHR	.126890	.174920	.588473E-01	-.187162	-.158764
AGEE	-.269441	-.354497	-.252280	-.140066E-01	.178704
INCOME	.166501	.200152	.987604E-01	-.995178E-01	-.143157
TYPEA	-.135370	-.940989E-02	.343165E-01	-.675747E-01	-.216910
TYPEB	.256833E-01	.156660	.102404	0.	.201752
LADDER	.256833E-01	-.261101E-01	-.143156	0.	.231865

	HUS	SATW	SATE	DIFF	DAYW
WTPA	_.344951	.272614	-.387680E-01	-.255243	-.768800E-01
WTPB	-.842726E-01	.229177	-.120864	-.218185	-.139507
WTPC	-.157969	.288164	-.176131	-.306207	-.837469E-02
EOW	0.	.102062	.251577	.223831	0.
YR	.234197	-.958877E-01	-.128785	.318929	-.398351E-01
HUS	1.00000	.956365E-01	-.392898E-01	.489391E-01	-.173423
SATW	.956365E-01	1.00000	-.102706	-.127930	.280873
SATE	-.392898E-01	-.102706	1.00000	.439224	-.376534
DIFF	.489391E-01	-.127930	.439224	1.00000	-.110228
DAYW	-.173423	.280873	-.376534	-.110228	1.00000
DAYE	.183331	.470043E-01	-.153015	-.601699E-01	.565552E-01
NACT	-.166810	.133238	-.507564	-.175321	.114597E-01
RECDAY	-.153205	-.004145E-01	-.529055E-02	.234990	.119774
RECHR	.222503	-.173002	.465526	.251630	-.890002
AGEE	.907796E-01	.477466	-.616654E-01	.661507E-01	.275908
INCOME	.168742	-.139296	.427765	.168018	-.902609
TYPEA	-.179405	-.427596	-.357000	-.511228	.326249E-02
TYPEB	.390434E-01	-.102062	.125789	.223831E-01	-.217262
LADDER	-.156174	-.102062	0.	.581960	-.965609E-01

Table 5 continued

	DAYE	NACT	RECDAY	RECHR	AGEE
WTPA	.235666	.286516	-.852894E-01	.126890	-.269441
WTPB	.276877	.394567	-.120806	.174920	-.354497
WTPC	.309793	.430566	-.719386E-01	.588473E-01	-.252280
EOW	-.605718	-.843259E-15	.349413	-.187162	-.140066E-01
YR	.145329	-.650408E-01	-.171888	-.158764	.178704
HUS	.183331	-.166810	-.153205	.222503	.907796E-01
SATW	.470043E-01	.133238	-.994145E-01	-.173002	.477466
SATE	-.153015	-.507564	-.529055E-02	.465526	-.616654E-01
DIFF	-.601699E-01	-.175321	.234990	.251630	.661507E-01
DAYW	.565552E-01	.114597E-01	.119774	-.890002	.275908
DAYE	1.00000	-.329723E-01	-.261460	.631871E-01	.124929
NACT	-.329723E-01	1.00000	.413992	-.967414E-02	-.159578
RECDAY	-.261460	.413992	1.00000	-.958815E-01	-.197778
RECHR	.631871E-01	-.967414E-02	-.958815E-01	1.00000	-.160450
AGEE	.124929	-.159578	-.197778	-.160450	1.00000
INCOME	.961842E-01	-.843614E-02	-.250365	.937700	-.186584
TYPEA	.147147E-01	.344840	.166699	-.156620	-.369599
TYPEB	.158939	.326365	.927263E-01	.163416	-.169830
LADDER	-.210249	.296695E-01	.115547	.139334	-.117305

Table 5 continued.

	INCOME	TYPEA	TYPEB	LADDER
WTPA	.166501	-.135370	.256833E-01	.256833E-01
WTPB	.200152	-.940989E-02	.156660	-.261101E-01
WTPC	.987604E-01	.343165E-01	.102404	
EOW	-.995178E-01	-.675737E-01	0.	0.
YR	-.143157	-.216910	.201752	.231865
HUS	.168742	-.179405	.390434E-01	-.156174
SATW	-.139296	-.427596	-.102062	-.102062
SATE	.427765	-.357000	.125789	0.
DIFF	.168018	-.511228	.223831E-01	.581960
DAYW	-.902609	.326249E-02	-.217262	-.965609E-01
DAYE	.961842E-01	.147147E-01	.158938	-.210249
NACT	-.843614E-02	.344840	.326365	.29665E-01
RECDAY	-.250365	.166699	.927263E-01	.115547
RECHR	.937700	-.156620	.163416	.139334
AGEE	-.186584	-.369599	-.169830	-.117305
INCOME	1.00000	-.768547E-01	.181265	.639757E-01
TYPEA	-.768547E-01	1.00000	.135147	-.371656
TYPEB	.181265	.135147	1.00000	-.250000
LADDER	.639757E-01	-.371656	-.250000	1.00000

Table 5 contined.

TABLE 6

Ordinary least squares regression estimates for experimental survey

Dependent Variable	Constant	EOW***	SATW	SATE	NACT	INCOME	F Statistic	R2	DW**
WTPA	-4.40*	-3.96	2.71	0.57	0.62	.0005	1.09	.41	0.96
	(-.45)	(-1.30)	(1.68)	(.33)	(0.30)	(.34)			
WTPB	-5.12	-3.21	1.01	0.57	1.48	.0003	1.87	.44	1.63
	(-.93)	(-2.33)	(1.46)	(0.65)	(1.39)	(.32)			
WTPC	-9.61	-5.12	1.88	0.97	2.68	-.00006	1.96	.45	1.40
	(-1.06)	(-2.24)	(1.64)	(0.65)	(1.52)	(-.04)			

*Numbers in parentheses are “t” statistics
**Durbin-Watson statistic
***East = 1, West = 0.
Number of observations was 20 and includes all observations including zero bids and no response recorded as zero.

TABLE 7

Regression Estimates for Property Value Study Experiment
Assessed Valuation

Dependent Variable	Independent Variables: Constant	Hous. sq ft	Total rooms	Age of house	Feet of Lake front.	Number Other bldgs.	F Stat.	R^2	DW**
Assessed Valuation (1983) West Okoboji	44,845 (2.02)*	14.30 (1.80)	3,178 (0.99)	-853 (-3.83)	1,373 (5.18)	10,237 (0.88)	23.20	.78	1.47
Assessed valuation (1983) East Okoboji	1,734 (.12)	17.60 (2.79)	4,623 (2.09)	-457 (-1.97)	364 (2.00)	1,389 (0.23)	12.46	.75	1.64

*Numbers in parentheses are "t" statistics
**Durbin-Watson statistic
Number of observations was 39 for West Okoboji and 27 for East Okoboji

TABLE 8

Regression Estimates for
Property Values Study, Replacement Value

Dependent Variable	Constant	House sq ft	Total rooms	Age of house	Feet of Lake front.	Number Other bldgs.	F stat.	R^2	DW**
	Independent Variables								
Replacement Value West Okoboji (1983)	7,046 (.43)*	8.61 (1.46)	3,705 (1.55)	-202 (-1.22)	574 (2.92)	-12,379 (-1.43)	11.89	.64	1.70
Replacement Value East Okoboji (1983)	-5,264 (-.41)	10.21 (1.80)	5,213 (2.62)	-268 (-1.24)	278 (1.83)	-9.811	8.94	.68	2.34

*Numbers in parentheses are “t” statistics
**Durbin-Watson statistic

Number of observations was 39 for West Okoboji and 27 for East Okoboji

TABLE 9

Pooled Regression Estimates, East and West Okoboji

Dependent Variable	Independent Variables: Constant	East or West West=1 East=0	House sq. ft.	Total rooms	Age of house	Feet of Lake frontage	No. of bldgs.	F Stat.	R^2	DW**
Assessed Valuation (1983)	-20,657 (-1.09)	84,189 (10.09)	15.93 (2.76)	3,836 (1.83)	-850 (-5.21)	1,037 (5.79)	1,600 (0.22)	66.42	.87	1.40
Replace-ment Value	-10.054 (-1.12)	17,826 (2.99)	9.22 (2.23)	4,694 (3.12)	-245 (-2.10)	449 (3.51)	12,249 (-2.37)	24.38	.71	1.85

*Numbers in parentheses are “t” statistics
**Durbin-Watson statistic
Number of observations was 66

TABLE 10

Average Imputed Bids or Compensation By Location, Present Value per Square Foot of Housing*

Location of Residence	Compensation Measures WTPA[1]	WTPB[2]	WTPC[3]
West Okoboji Lake	6.26	3.03	4.69
East Okoboji Lake	6.01	4.31	7.02

*Presumes a 5 percent real rate of interest (net of inflation) and the appropriate square feet of housing is 2,152 for West Okoboji and 1,415 for East Okoboji, and the average assessed valuation (1983) for West Okoboji is $161,716, and for East Okoboji is

[1]Willingness to pay in increased property taxes for improved water quality. (From B to A on ladder)

[2]Amount of compensation in reduced property taxes for a decrease in water quality. (From B to C on ladder)

[3]Amount of compensation in reduced property taxes for a decrease in water quality. (From B to D on ladder)

NOTE: Because of differences in weights between East and West Okoboji, these estimates are lower than those derived over the entire sample and reported in the text in Table 2.

TABLE 11

Qualitative Preferences for Water Quality
Ranked Importance of Characteristics
for Purchase Decisions on Housing
1=Highest; 2=Second Highest; 3=Third Highest

Location Rank Ordering	Characteristics		
	Price	Location	Water Quality
West Okoboji			
1	2*	4	4
2	0	5	3
3	5	1	3
East Okoboji			
1	7	3	0
2	1	7	2
3	2	11	5

* Number denotes how many individuals ranked characteristic at a given level.

TABLE 12

Qualitative Assessment of Substitution
and Complementarity in Water Based Recreational
Activities, Lake Okoboji Survey

Activities	Number of Responses*		
	Complements	Substitutes	Neutral
Fishing/Boating	16	0	2
Swiming/Fishing	4	7	5
Drinking/Swiming	5	4	6
Swiming/Boating	11	4	4
Drinking/Boating	3	3	10

*Total will not sum to 20 since some individuals did not respond to all activity combinations.

TABLE 13

Substitution and Complementarity
Revealed Through Bids

Pair of Activities	Revealed through bids: Complement	Substitute	Neutral	No Recorded Response
Boating/Fishing	3	3	9	5
Fishing/Swimming	4	4	5	7

*In this part of the experiment, some individuals refused to respond and others stated they did not understand the question. The modal response was to levy their entire bid to one or the other of the activities, thus implying neutrality across the activity pairs.

TABLE 14

Time Spent Recreating by Location
East and West Okoboji Lakes

Satisfaction Measure for	East Okoboji Residents on East Okoboji	East Okoboji Residents on West Okoboji	West Okoboji Residents on East Okoboji	West Okoboji Residents on West Okoboji
Very Satisfied	0	6	0	4
Satisfied	3	2	1	4
Neutral	5	1	4	1
Dissatisfied	0	1	4	1
Very Dissatisfied	2	0	1	0
Time Allocations Which lake is utilized more.	6	4	0	10